Testing Interest Rate Contagion in Latin America Using a Modified Taylor Rule

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Abstract

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Studies that focus on explaining Latin American central bank's monetary policy objectives usually do not look at the contagion effect from the U.S. Using the Taylor rule, a rule developed in 1993 to explain monetary policy in the U.S. I will test for the applicability of this rule to three Latin American economies; Mexico, Brazil, and Colombia. I will then modify the equation in order to include U.S. variables so as to test for a contagion effect from the U.S. to these Latin American economies. I find evidence that in certain cases these variable are statistically significant in the data sample, and that further research is warranted in order to determine if the equation actually measures any contagion effect.

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I. Introduction

In the last few decades there has been a rapid integration of international financial markets due in part to the quick modernization of many emerging economies worldwide. This phenomenon of financial integration has brought about many positive gains to the global economy as a whole. Starting in the late 1980's up till recently, investors seeking higher rates of return and the opportunity to diversify their portfolios, have created a surge in demand for international investments. This increased demand coupled with the dismantling of restrictions by local governments, deregulation by domestic financial markets, and the improved economic environment, have allowed many economies to increase their role in the global economy. Benefits that have been seen globally include, international risk sharing for consumption smoothing, positive impact of capital flows on domestic investments and growth, enhanced macroeconomic discipline, increased efficiency, and increased banking system efficiency and financial stability (Agenor, 2001). But it is important to note, that these gains have not come cost free. As we can see with a well knitted sweater, when one string comes undone, it can pull many other threads with it, destroying the deeply intertwined web. Instances such as the Mexico crisis of 1994 and the Thai currency crisis of 1997 awoke the world to the dangers of financial contagion in this new globalized economy. As Lawrence Summers so well put during an interview with Commanding Heights of PBS, "Contagion is very much a feature of this new world. It's a reflection of globalization; it's a reflection of information technology. When bad things happen in one place, it affects other places for any number of reasons" (Commanding Heights, 2001).

As contagion is a relatively new topic in modern economics it is very difficult to define, due to the differing view on what constitutes this economic event. One common definition is that:

> When two economies are located in separate geographic regions, have very different structures, and have virtually no direct linkages through channels such as trade, the propagation of a crisis from one to another is contagion (Clessens & Forbes, 4).

Some though have coined this type of contagion, “shift-contagion”. The disagreement emerges when economists are studying highly integrated and correlated economies, for example two economies in similar geographic regions, with similar market structures, and with strong trade and financial interconnectivity. In these two integrated economies, financial volatility in one should then clearly translate into a shock in the other, due to the nature of their economic interdependence. My thesis will focus on the latter definition in an attempt to determine whether the United States federal funds rate has a statistically significant affect on three Latin American central bank’s monetary policy.

Interest rates, are very strong determinates of an economy as a whole, and therefore can serve as a good measure for financial contagion. The federal funds rate is the rate at which unsecured loans of reserve balances, depository institutions make to one another. This rate is closely watched by the global financial market, because of the wide impact it can have on the value of the dollar and the amount of lending going into new economic activity. The interest rate level affects the health of the economy by influencing the supply and demand for credit. At lower interest rates the cost of borrowing money is smaller therefore, people and businesses borrow more. This leads to an increase in business investments, making the economy grow at a faster rate. In turn when rates are higher, the cost of credit for consumer and businesses is higher, decreasing demand and slowing economic growth.

It is well understood in international macroeconomics that a large open economy, is a nation whose policy actions affect world prices and income, while a small open economy is a price taker in the global economy. Since the U.S. is one of the largest open economies, when the Federal Reserve changes its interest rates, it should then translate into a change in rates in smaller open economies. I have chosen to focus on Brazil, Mexico and Colombia in the time period of January 1996 to September 2005, as they are the ranked respectfully the first, second and fourth largest economies by GDP in Latin America:

Table 1.1

Rank in world	Country	GDP
9	Brazil	$1,993,000 million
11	Mexico	$1,563,000 million
23	Argentina	$573,900 million
28	Colombia	$395,400 million

I have omitted Argentina from my sample as it experienced a massive debt crisis from 2001-2002, which falls right in the middle of the time period used. These three economies can be considered stable growth economies during this period and therefore offer viable data for analysis.

The equation that will be central to my analysis of the US federal funds rate as a variable in determining central bank policy in the three Latin American economies was derived in 1993 John B. Taylor. Taylor proposed one of the most respected and commonly accepted equations for U.S. monetary policy, proposing that the federal funds rate can be described by an interest rate feedback rule of the form:

(1) $i^{*}t = \pi t + \delta(\pi t - \pi^{*}t) + \gamma y\text{t} + r^{*}$

Where $i{*}t$ denotes the short-term Federal Reserve's interest rate, πt, is the inflation rate, $\pi{*}t$ is the target level of inflation, yt is the output gap, and r* is the equilibrium level of the real interest rate. The model uses inflation and the output gap, two variables commonly seen as features of an optimal monetary policy in order to explain how interest rates by the Federal Reserve are set. The rule states that when inflation and/or output are above the target level, the short-term federal funds rate will rise in reaction. Because the parameters of $\pi{*}t$ and r* can be combined into one constant $\mu = r{*} + \delta\pi{*}t$ we can see that the Taylor rule can be defined as

(2) $i^{*}t = \mu + \lambda\,\pi t + \gamma y\text{t}$ given $\lambda = 1 + \delta$

The Taylor principle states that $1 + \delta > 1$, in other words the coefficient for inflation when it exceeds its target levels must be positive, leading to a larger increase in the real interest rate (Molodtsova, 2009).

In my analysis of interest rate contagion, I have derived a variation of the Taylor rule for the three Latin American economies that will include a local Taylor model, as well as two variations of the United States Taylor model:

(3) $i^{*}latam = \mu + \lambda\,\pi latam + \gamma y\text{latam} + \beta_1\, i^{*}us$

(4) $i^{*}latam = \mu + \lambda\,\pi latam + \gamma y\text{latam} + \lambda\,\pi us + \gamma y\text{us}$

Equation three adds the federal funds rate as a determinant in Latin American interest rate decisions, while equation four uses the determinants of the federal funds rate in order to model Latin American rates. The purpose behind testing these two theoretical equations is to show if there exists statistically significant evidence that U.S. monetary policy influences Latin American monetary policy. Therefore, if I find the variables to be statistically significant within the parameters of a modified Taylor rule, then I will be able to theorize that there exists the possibility of certain levels of interest rate contagion.

The rest of the paper is organized into four more sections: Section II will look at past research and papers done with Taylor rule manipulations. Section III will describe the data used in my model. Section IV will discuss and analyze my empirical results for my data, finishing with my final interest rate model. Section V will summarize my thesis.

II. Literature Review

Since the publication of Taylor's paper, "Discretion Versus Policy Rule in Practice" many have used this basic formula to create interest rate models for other developed economies such as Japan and the European Union, all with varying degrees of success. In one of his latter papers, "Using Monetary Policy Rules in Emerging Market Economies" John B. Taylor ventured to say that the use of monetary policy rules in emerging market economies, have many of the same benefits that have been found in the research and in practice of developed economies. It He clearly emphasizes that the Taylor rule is only applicable to emerging markets that don not choose a monetary policy of permanently fixing their exchange rates. He goes on to conclude that the Taylor rule provides a framework for monetary policy, but modifications must be made to the traditional rule in order to properly model for those economies. Taylor goes as far as to suggest that a possible solution would be to add some new variable to that countries specific Taylor rule in order to properly model for the difference between an emerging market and a mature economy (Taylor, 1999).

There are two papers that related directly to my study, where the authors have chosen to study the applicability of the Taylor rule to Latin American economies, the first looking at the LAC-7, and the second focusing only on Mexico. In the first paper by Moura et al, "What Can Taylor Rules Say About Monetary Policy in Latin America?" the authors examine the way monetary policy has been conducted recently in the seven largest Latin American economies, Argentina, Brazil, Chile, Colombia, Mexico, Peru, and Venezuela. Using monthly data ranging from January 1999 to January 2008, they tested the money market rate inter-bank short-term interest rates (the equivalent to the federal funds rate) against the countries inflation and the seasonally-adjusted industrial production data as a proxy for the output gap. They tested 16 alternative Taylor rules for the LAC-7, in order to find the best fit for each economy. What they found was that ultimately monetary policy seemed to be an endogenous variable whose behavior could be captured by a Taylor rule specification. All countries showed some predictability in at least one horizon and at more than one specification there was strong empirical support for out of sample predictability. In the end they suggested that future studies in the subject matter should attempt to reflect another macroeconomic variable that could affect monetary policy in those economies (Moura et al, 2010).

Similarly, Galindo et al in their paper, "La Regla de Taylor para México: un Análisis Econométrico" takes an in depth look at applying the Taylor rule in order to explain monetary policy in Mexico during the time period of 1990-2000. In their work, they use nominal interest rates as a function of inflation, the output gap, and the first order lag of the nominal interest rate. His results are as follows:

Table 2.1

Mexico's Interest rate model (Galindo)	Coefficient	T-statistic	P-value
Mexico's Inflation	0.65	7.80	0.000
Mexico's output gap	-0.16	-0.67	0.501
Mexico Money Market Rate (T-1)	0.22	2.19	0.034
R^2 = 0.75			

As we can see from this output, Mexico's central bank's monetary policy can be modeled using the Taylor rule excluding the output gap which is not statistically significant in their sample data, with a p-value of 0.501. What this showed Galindo et al was that the strategy by Mexico's central bank was successful in controlling inflation but it did not act as an optimal monetary policy since the bank clearly ignored the Mexican output gap (Galindo et al, 2003). I will return to their results latter in the paper in the analysis section of the thesis.

III. Data Description

In order to test the modified Taylor equations presented by equations (3) and (4) in my introduction, I first had to gather the monthly U.S. federal funds rate as well as the money market rates for Mexico, Brazil, and Colombia. I set the data as a time series by generating the date variable and setting it starting January 1996 through September 2005, these specific dates were chosen as they represent a time of relative economic stability for the three Latin American economies. Chart 1 shows the interest rates for the four economies plotted against time.

Once the endogenous variables where placed in STATA and set as a time series, I had to collect the CPI for the four countries. I collected the CPI data set from January 1995 in order to be able to calculate the monthly inflation rate starting January 1996. This was done by taking the natural log of the CPI in the month of the current year and subtracting it from the natural log of the CPI in the same month of the previous year, thereby calculating inflation for that month. Then that number was multiplied by 100 in order to put inflation in percentage terms, as the Taylor rule specifies. This was done for all four economies for all 116 months in the data set. Chart 2 shows the inflation for the four economies plotted against time.

The output gap is the difference between the projected production for an economy and the actual production during that month. The output gap is defined as the difference between the actual output of an economy, and the output that the economy would be at, under full capacity or at its potential output. When the output gap is negative, the economy is therefore producing below its full capacity, and is therefore being inefficient in regards to production. When the output gap is positive, then the economy is producing at a level higher than it should be, and is viewed as an indicator of inflation.

In order to find the output gap for each of the four economies, I had to take some measure of production and run a regression on the data set. I chose to use the seasonally-adjusted industrial production index for the four economies, the way Moura et al did in their study on the LAC-7 economies. In order to model for the different trends in the industrial production index, I used both a linear and quadratic output gap for my study, and therefore had to generate two trend variables, one denoted as trend, would represent the linear trend variable, and the second denoted as trend2 would represent the quadratic trend variable. I then ran a linear and quadratic trend regression on the industrial production index for the four economies, each followed by generating a predicted fitted variable for the regressions. This provided me with the projected linear and quadratic industrial production values for each country. To calculate the output gap, which I would use for the Taylor rule, I had to generate a new variable for each economy, denoted (first three letters of country) ipgap which would be equal to the actual industrial production minus the predicted industrial production. Variables that where calculated using the quadratic expression, where denoted using a 2 at the end of the name. Chart 3 shows the linear output gap for the four economies plotted against time. Chart 4 shows the quadratic output gap for the four economies plotted against time.

All data was obtained using the International Financial Statistics database provided by the International Monetary Fund.

IV. Analysis

IV. 1) $i^{*}t = \beta_1 \pi t + \beta_2\, y\mathrm{t} + \varepsilon$ (*linear and quadratic output gap)*

The regression for a traditional Taylor rule equation for the four economies reveal the actual applicability of the original model to the data sample. Using the calculated linear output gap for the Taylor rule, the regression for the U.S. federal funds rate reveals that both the inflation and the output gap coefficients are positive, 0.533 and 0.271 respectively. And that they are both statistically significant in the data sample.

Table 4.1

US Taylor (linear)	Coefficient	T-statistic	P-value
US Inflation	0.533	2.86	0.005
US output gap	0.271	5.24	0.000
R^2 = 0.264			

The coefficients for the model demonstrate that inflation plays a greater role in determining the U.S. federal funds rate than does the output gap. In other words, if inflation rises by one then the corresponding interest rate response, all other things equal would be to rise by 0.533. Whereas with the output gap, if the gap grew by one, then the appropriate interest rate response, all other things equal, would be to rise by 0.271. But as I mentioned earlier, the linear model is not the only method for calculating the output gap. In fact, using the linear trend in order to calculate the output gap assumes that output in the U.S. is following a straight line trend, which many economists would argue, a mature economy does not. Therefore we also generate the same regression using the variable, **usipgap2**, which represents the quadratic output gap.

Table 4.2

US Taylor (quadratic)	Coefficient	T-statistic	P-value
US Inflation	0.122	0.59	0.553
US output gap	0.428	6.92	0.000
R^2 = 0.298			

As we can see, the values of the coefficients have changed, and U.S. inflation can now be rejected as a statistically significant explanatory variable for the federal funds rate. This regression therefore implies that monetary policy is only governed by the want to control deviations from the output gap in the U.S. Seeing as the linear model is a better fit to the traditional Taylor rule, the linear output gap will be the statistic used from here on out, when referring to the U.S. output gap.

The next step was to run the regressions for the three Latin American economies being studied in order to see if the rule was applicable in anyway, and in order to gain some insight into their individual monetary policy based on their own inflation and output gap. The linear results are as follows:

Table 4.3

Mexico's Taylor (linear)	Coefficient	P-value	Brazil's Taylor (linear)	Coefficient	P-value	Colombia's Taylor (linear)	Coefficient	P-value
Mexico's Inflation	1.133	0.000	Brazil's Inflation	0.063	0.734	Colombia's Inflation	1.877	0.000
Mexico's output gap	0.634	0.000	Brazil's output gap	-0.739	0.000	Colombia's output gap	-0.042	0.280
R^2 =0.86			R^2=0.109			R^2 =0.844		

Beginning with Mexico, by looking at the p-values for both explanatory variables, we see that they are both statistically significant in explaining the nominal money market rate set by the central bank of Mexico. The coefficient for inflation of 1.133 shows that the central bank's main monetary policy objective is to control inflation, therefore the short term nominal interest rate reacts strongly to price changes, especially when you compare it to the U.S. coefficient for inflation in table 4.1. Unfortunately the linear Taylor rules seem not to apply to Brazil or Colombia, since in each one of the regressions one of the explanatory variables is not statistically significant. Although Brazil's Taylor regression can be rejected as statistically significant, it gives us insight into what could potentially be guiding the countries monetary policy, the output gap. Although the negative coefficient of -0.739, does not seem fitting in a traditional Taylor model, we are applying the rule to an emerging market, therefore we must look at it in a completely different way. A possible explanation for this negative coefficient is that as the output gap in Brazil gets more positive, the central bank lowers the money market rate in order to encourage growth in its own economy by lowering the cost of credit. This would then mean that when the output gap is negative (the industrial production index is falling below the linear trend) Brazil raises the money market rate. This could possibly be to attract international investors with a higher rate of return in Brazil, thereby increasing their international reserves. In Colombia we see the exact opposite effect. We see that inflation is a statistically significant explanatory variable for the central banks money market rate, while the output gap is not. This shows us that like Mexico, Colombian monetary policy is set to control for inflationary pressures, with disregard for the industrial production differential. The negative coefficient for the output gap can be ignored since it is statistically insignificant, and because the actual coefficient is such a small decimal number.

When using the quadratic output gap as the variable in the three Latin American regressions, the only one that showed itself as a better fit for the Taylor rule application is Brazil:

Table 4.4

Brazil's Taylor (quadratic)	Coefficient	T-statistic	P-value
Brazil's Inflation	-0.174	-1.21	0.338
Brazil's output gap	-1.401	-5.90	0.000
R^2 = 0.236			

Although this regression still maintains inflation to be statistically insignificant in determining Brazils central bank's monetary policy, it does decrease the p-value significantly enough to where we can say that the quadratic model is a better fit than the model that used the linear output gap, given that R^2 value is 0.127 greater than in the linear model. This is important for our future models as from here on out, when I refer to the output gap in any model relating to Brazil, I will be using the quadratic trend variable for the output gap and not the linear trend variable.

If we go back and look at table 2.1, which shows the work by Galindo et al we see that in his study he used the first order lag of Mexico's money market rate along with Mexican inflation and the output gap in order to test the Taylor rule. I decided to emulate and compose a similar regression for my data set, to see if there was any consistency between his findings and mine. Looking first at inflation the coefficients in both regressions are positive, Galindo's showed a coefficient of 0.65 while mine showed a coefficient of 0.183. Other discrepancies can be seen when comparing the output gap, Galindo found that the output gap was not a statistically significant variable in explaining Mexico's central bank policy, while my data series showed that not only was the output gap statistically significant, but its coefficient was close to that of inflation, with the value of 0.138. Galindo's results also showed that the first order lag was a weak indicator the future rates, since it only had a coefficient of 0.22 suggesting that money market rates from the month before have a small positive effect on the nominal interest rate. While my results showed that the first order lag of the Mexican money market rate, showed significant explanatory powers for the current rate, with a coefficient of 0.809. The results for my regression can be found in appendix table 7.2. The fact that the lag showed such a statistically significant explanatory power in my data set, I decided to test for the fourth order lag of the money market rate for the three Latin American economies.

IV. 2) $i^{*}t = \beta_1 \pi t + \beta_2 y\text{t} + \beta_3 i^{*}t - 4 + \varepsilon$

This section of the analysis will focus on the same Taylor rule as the one seen in section 1, but adding a forth order lag of the home economy's interest rate in order to model the affects of the interest rate from 4 months before. Running the regression for the U.S. federal funds rate using a forth order lag, we find that all the explanatory variables are statistically significant at the 1% level. The coefficient for inflation, 0.219, and output gap, 0.063, are reduced to smaller decimals, but the inflation coefficient remains the dominant force in guiding monetary policy, as it did in table 4.1. The coefficient for the lag of the federal funds rate, 0.879, suggests that past interest rates strongly influence those in the future. More importantly, the interest rate from 4 periods back is slightly greater than the current interest rate if inflation and output gap stay the same, suggesting that the federal funds rate is a relatively stable rate. Table 7.1 in the appendix details coefficients, t-statistics, and p-values for each of the variables used.

After running the same regressions for Mexico, Brazil, and Colombia, the results ran as follows:

Table 4.5

Mexico's Taylor L(4)	Coefficient	P-value	Brazil's Taylor L(4)	Coefficient	P-value	Colombia's Taylor L(4)	Coefficient	P-value
Mexico's Inflation	0.904	0.000	Brazil's Inflation	-0.332	0.069	Colombia's Inflation	0.938	0.000
Mexico's output gap	0.525	0.000	Brazil's output gap	-0.991	0.000	Colombia's output gap	0.09	0.005
Mexico Money Market Rate (T-4) R^2 = 0.83	0.185	0.187	Brazil Money Market Rate (T-4) R^2 = 0.33	0.322	0.000	Colombia Money Market Rate (T-4) R^2 = 0.89	0.501	0.000

The regression using the traditional Taylor rule with a fourth order lag for Mexico maintains a very similar identity to the regression in table 4.3, again with home inflation being the predominant guide for the central bank’s monetary policy. All values are statistically significant at the 1% level with the exception of the lag which is only significant at the 10% level. Suggesting that past interest rates in Mexico are not a good indicator for the future rates, showing that within a 4 month period all things unchanged the interest rate in Mexico will fall by 0.815. Brazil's regression maintains that the output gap is the predominant force in ruling monetary policy for the central bank. Surprisingly after adding the fourth order lag of the money market rate, inflation becomes a statistically significant variable. Oddly enough, the coefficient is negative, demonstrating another deviation from the traditional Taylor rule in Brazilian monetary policy. The lag coefficient like Mexico's suggest that interest rates from four months back differ from the current rate, though in brazil, not nearly to the degree that they do in Mexico. Colombia's regression, similarly to the one found on table 4.3, suggests that inflation guides the central bank's monetary policy. Given by the output gaps coefficient having a value of 0.009, we can see that its effect on the interest rate is very small, but nonetheless it is statistically significant at the 5% level and is therefore an important variable to include. The fact that Colombia's lag coefficient is 0.501, shows that out of the three Latin American economies its current interest rate is most similar to the interest rate four months back, as long as everything else is held the same. For the four economies it seems that adding a fourth order lag to the regression helped to account for the nature of a time series that uses monthly money market rates. In that they remain relatively unchanged in the U.S. during periods of stability while in emerging markets it is clear that monthly rates do vary drastically in comparison to those of the U.S.

IV. 3) $i^*_{latam} = \beta_1 \pi_{latam} + \beta_2 y_{latam} + \beta_3 i^*_{us} + \varepsilon$

The following regression is the first that combines the U.S. federal funds rate as an explanatory variable for the three Latin American central banks Taylor rule. The goal, of these regressions is to test if central bank policy from the U.S. has a statistically significant contagious effect on the monetary policy of the three Latin American economies. The results for the three regressions are as follows:

Table 4.6

Mexico's Taylor + US FF	Coefficient	P-value	Brazil's Taylor + US FF	Coefficient	P-value	Colombia's Taylor + US FF	Coefficient	P-value
Mexico's Inflation	1.05	0.000	Brazil's Inflation	-0.054	0.697	Colombia's Inflation	1.77	0.000
Mexico's output gap	0.49	0.004	Brazil's output gap	-1.641	0.000	Colombia's output gap	-0.028	0.456
US FedFunds rate R^2 = 0.86	0.43	0.251	US FedFunds rate R^2 = 0.39	1.44	0.000	US FedFunds rate R^2 = 0.85	0.395	0.025

Looking first at Mexico's regression output, the p-value of 0.251 shows that the U.S. federal funds rate is not a statistically significant explanatory variable for the Mexican money market rate when it is added to a traditional Taylor model. But if you refer back to table 4.3, the output does show that the coefficients for inflation and the output gap are consistent. Given that the federal funds rate is statistically insignificant, we can ignore the R^2 value of 0.862. Brazil's regression on the other hand, shows that the federal funds rate plays an important role in their monetary policy decisions since it is statistically significant at the 1% level. And consistent with the previous regressions, inflation is shown to be statistically insignificant while the output gap is statistically significant. The output gap coefficient for Brazil remains similar to the regression on table 4.4, going from a -1.401 to -1.641, showing further evidence that Brazils monetary policy during the period may be guided not by inflationary pressures but by the output gap. Colombia's regression for the modified Taylor rule shows that the output gap is not statistically significant but that the federal funds rate is statistically significant, and therefore could play a role in determining monetary policy.

Given that the three regressions for the modified Taylor rule gave inconclusive results, I decided to move on to another possible regression that would combine Latin American Taylor rule with a U.S. Taylor rule.

IV. 4) $i^*_{latam} = \beta_1 \pi_{latam} + \beta_2 y_{latam} + \beta_3 \pi us + \beta_4 y us + \varepsilon$

Theoretically, if the Taylor rule ran in analysis section 3 was shown to be statistically significant for all three variables, then this regression should show that the U.S. inflation and U.S. output gap coefficients should be the exact same as the ones on table 4.1.

Table 4.7

Mexico's Taylor + US Taylor	Coefficient	P-value	Brazil's Taylor + US Taylor	Coefficient	P-value	Colombia's Taylor + US Taylor	Coefficient	P-value
Mexico's Inflation	1.12	0.000	Brazil's Inflation	-0.11	0.566	Colombia's Inflation	1.864	0.000
Mexico's output gap	-0.281	0.171	Brazil's output gap	-1.166	0.000	Colombia's output gap	0.049	0.285
US Inflation	-0.965	0.127	US Inflation	-1.855	0.018	US Inflation	-1.928	0.001
US output gap	1.218	0.000	US output gap	-0.106	0.479	US output gap	0.515	0.000
R^2 =0.878			R^2=0.275			R^2 = 0.876		

As we can see by the difference in the coefficients for the U.S. statistics and the statistical insignificance from the regression ran in the past section, neither is the case. But the results from this regression still provide insight into the respective economies monetary policy in that they show that the U.S. could play some role in determining monetary policy. Maybe not through interest rates directly, but through the instruments that guide monetary policy. Given that in these regressions at least one of the explanatory variables was shown to be statistically insignificant, I decided to remove the variable that had been constantly the most statistically insignificant from the Latin American economy throughout all past regressions, to see if that would affect the regression output. Therefore for Mexico and Colombia it meant removing their output gap and for Brazil its own inflation. What I found was rather interesting and is represented in the table below:

Table 4.8

Mexico's model	Coefficient	P-value	Brazil's model	Coefficient	P-value	Colombia's model	Coefficient	P-value
Mexico's Inflation	1.12	0.000	Brazil's output gap	-1.104	0.000	Colombia's Inflation	1.813	0.000
US Inflation	-.911	0.131	US Inflation	-2.096	0.011	US Inflation	-1.825	0.001
US output gap	.888	0.000	US output gap	-0.020	0.898	US output gap	0.471	0.000
R^2 =0.877			R^2=0.273			R^2 =0.875		

Beginning with Mexico, we see that all explanatory variables are statistically significant at the 1% level and that it has a high R^2 of 0.877. What the coefficients tell us about the model is that as before, Mexican inflation has an almost one to one relationship with the money market rate, U.S. inflation exerts a negative pressure on the interest rate also close to a one to one relationship, and U.S. output has a positive coefficient also close to one. Brazil's on the other hand, maintains that the U.S. output gap has no statistical significance as an explanatory variable and as such should be ignored in the model. As with the other Brazil regressions, the output gap continues to put negative pressure on monetary policy. Even more interesting, U.S. inflation has a negative pressure on Brazil's money market rate, as it did in Mexico's regression. Colombia's model is similar to Mexico models in that both have coefficients > 1 for their own inflation, and negative coefficients for U.S. inflation, coupled with positive coefficients on the U.S.

output gap. This could suggest that the interest rate behavior of these two economies could possibly have been guided by the same monetary policy.

The result that truly stood out in this regression is the negative U.S. inflation coefficient for the three Latin American economies. By looking at Chart 1 and Chart 2, this occurrence could have a very simple explanation. If you begin by looking at chart 2 you can see that U.S. inflation during the period is very stable, making the variable almost a constant in the regression. If you then look at chart 1 you can clearly see that interest rates in the three Latin American economies are running a negative trend line, therefore as the regression moves through the time series, it calculates the stable U.S. inflation statistic as having a negative effect on the money market rates for the three economies.

But another more likely explanation, given that U.S. inflation is not a completely static variable, could be that as inflation in the U.S. rises, Latin American central banks want to instigate economic growth by lowering rates in order to capture the gains from the rising prices in the U.S. They would want to drive growth because higher inflation means higher prices for the goods they are exporting to the U.S. benefiting both the producers in Latin America, as well as the government collecting tax revenue, further stimulating the economy.

IV. 5) $i^*_{latam} = \beta_1 \pi_{latam}$ or $\beta_2 y_{latam} + \beta_3 \pi us + \beta_4 y us + \beta_5 i^*_{latam} t - 4 + \varepsilon$

The individual Taylor rule regressions with a forth order lag on their own money market rate showed statistical significance across the board, so I decided to take that regression and the regression from analysis section 4 and combine them. By combining the two, I hoped to show that U.S. inflation and the U.S. output gap do show a statistically significant effect on the Latin American economies central bank policies. The results are as follows:

Table 4.9

Mexico's Interest rate model	Coefficient	P-value	Brazil's Interest rate model	Coefficient	P-value	Colombia's Interest rate model	Coefficient	P-value
Mexico's Inflation	0.942	0.000	Brazil's output gap	-0.732	0.001	Colombia's Inflation	1.227	0.000
US Inflation	-.946	0.108	US Inflation	-1.793	0.044	US Inflation	-1.254	0.016
US output gap	0.788	0.000	US output gap	0.106	0.468	US output gap	0.292	0.018
Mexico Money Market Rate (T-4)	0.147	0.256	Brazil's Money Market Rate (T-4)	0.292	0.003	Colombia's Money Market Rate (T-4)	0.346	0.000
R^2 =0.852			R^2 = 0.336			R^2 = 0.895		

Comparing Mexico's results to those found on table 4.5, we can see that the coefficients for Mexico's inflation rate and the fourth order lag of the money market rate are rather consistent between the two regressions. The only difference is that the forth order lag is now not statistically significant at the 15% level. When comparing the coefficients for the U.S. variables in Mexico's regression, we see that they as well are very similar to the coefficients observed in table 4.8. What this tells us about Mexico's regression, is that when we combine the equations from analysis section 2 and the modified regression from analysis section 4, we can assume that this is a more complete model for my hypothesis. It is a more complete model because it includes the explanatory variables for the predominant monetary policy objective for Mexico, inflation, as well as including a lag variable for its own money market rate, and the explanatory variables in the U.S. Taylor rule. In the case of Brazil, what we find in this final regression model is that U.S. output gap seems to show no statistical significance as an explanatory variable, which is consistent with the results found in the regression for analysis section 4. Similar to Mexico's regression, this model seems to be a good combination of Brazils best fit Taylor rule along with the parameters set forth for my theory. Finally, Colombia seems to have the best fit out of the three regressions, showing a very high R^2 of 0.895, and statistical significance for all four explanatory variables at a 2% level.

The following equations represent the modified Taylor rules for the three Latin American economies.

(Mexico) $i^*_{mex} = 0.942\,\pi_{mex} - 0.946\,\pi us + 0.788 y\text{us} + 0.147\, i^*_{mex}\, t-4$

(Brazil) $i^*_{bra} = -0.732\, y_{bra} - 1.793\,\pi us + 0.106 y\text{us} + 0.292\, i^*_{bra}\, t-4$

(Colombia) $i^*_{col} = 1.227\,\pi_{col} - 1.253\,\pi us + 0.292 y\text{us} + 0.346\, i^*_{col}\, t-4$

Although these three models are not perfect, in fact they are flawed in that two of them include variables that are considered statistically insignificant as explanatory variables in the model, for the purpose of testing my theory I believe that they are the models that tell the best story. They maintain consistency throughout explanatory variables, and show that in certain cases, U.S. inflation and the U.S. output gap can have statistical significance in explaining their monetary policy. Weather this proves in any way that interest rate contagion is occurring is another story, but what it does show is that further research in the subject matter is warranted. Chart 5, 6, and 7 show the actual money market rates for the three economies plotted against the fitted values for the final model. The fitted values seem to follow the trend for the three money market rates quite well. Unfortunately, when I looked at the autocorrelation function and the partial autocorrelation function of the residuals of all three models, we can clearly see there are still patterns in the data, and that the residuals in no way represent white noise. Charts 8 – 13 show the AC and PAC for the residuals of the three best fit models.

V. Conclusion

The purpose of this paper was to test whether U.S. monetary policy played any role in the monetary policy of three of the largest Latin American economies, to test for a measurable contagion effect. I tested this by taking the traditional Taylor rule and applying it to the three economies, then modifying it to include explanatory variable from the U.S. After running various regressions to find the model that included variables from the home economy's Taylor rule as well as variable from the U.S. Taylor rule, I found a model that showed signs that this may not be the model of best fit for these three economies. But the model did show certain U.S. variables could potentially influence Latin American monetary policy. The explanatory variable that most stood out was U.S. inflation, and how it exerted a negative pressure on all three economies money market rate. Although this could just be explained by the nature of the data I believe this needs to be studied further, as there may be some underlying reasoning for this result.

Another interesting result of this study was the coefficients for the Taylor rule that included the fourth order lag. The U.S. showed a coefficient of nearly one, 0.879, for the forth order lag of the federal funds rate, demonstrating that interest rates in the U.S. are stable when compared from four months back. While Latin American economies showed coefficients for the fourth order lags of their money market rates, all < 0.51, demonstrating that there is a high degree of volatility in the money market rate, when compared 4 month back.

Though the autocorrelation function and the partial autocorrelation functions for the residuals of my model show that there is evidence of a pattern that has not been accounted for by my model, the purpose of this study was not to build a forecast model. But rather to test for the statistical significance of certain explanatory variables on the money market rates of three Latin American economies from January 1996 to September 2006. Ultimately, the study has neither proved nor disproved the possibility of U.S. contagion using a modified Taylor rule for the three Latin American economies. But I believe it has warranted future testing on the possibility of measuring interest rate contagion using the Taylor rule.

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rt=d&_docanchor=&view=c&_searchStrId=1287248405&_rerunOrigin=google&_acct=C000050221&_version=1&_urlVersion=0&_userid=10&md5=9eb68f5e5da4c2aba1fffced0d19b43f>.

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VII. Appendices

Chart 1: Interest rates Jan-96 to Sept-05

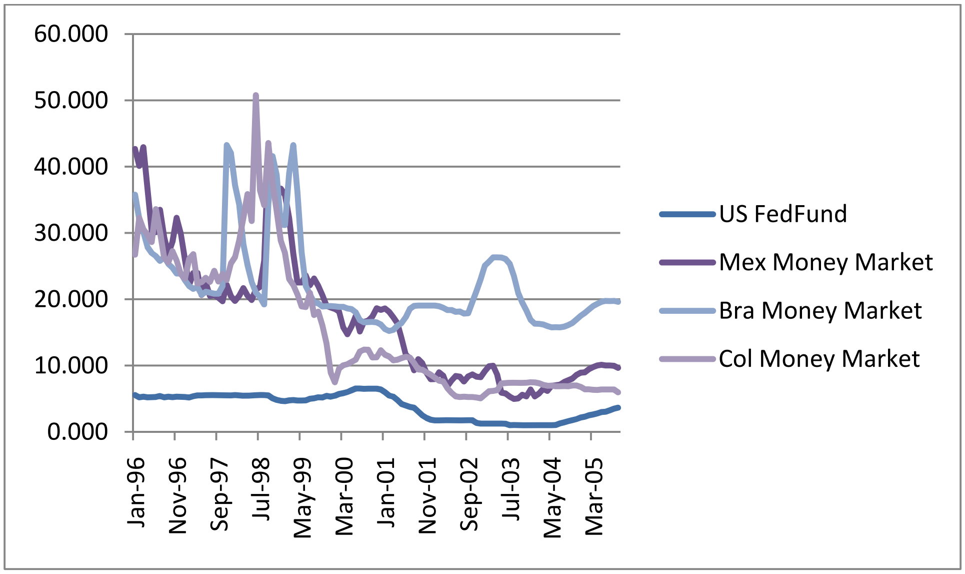

Chart 2: Inflation rates Jan-96 to Sept-05

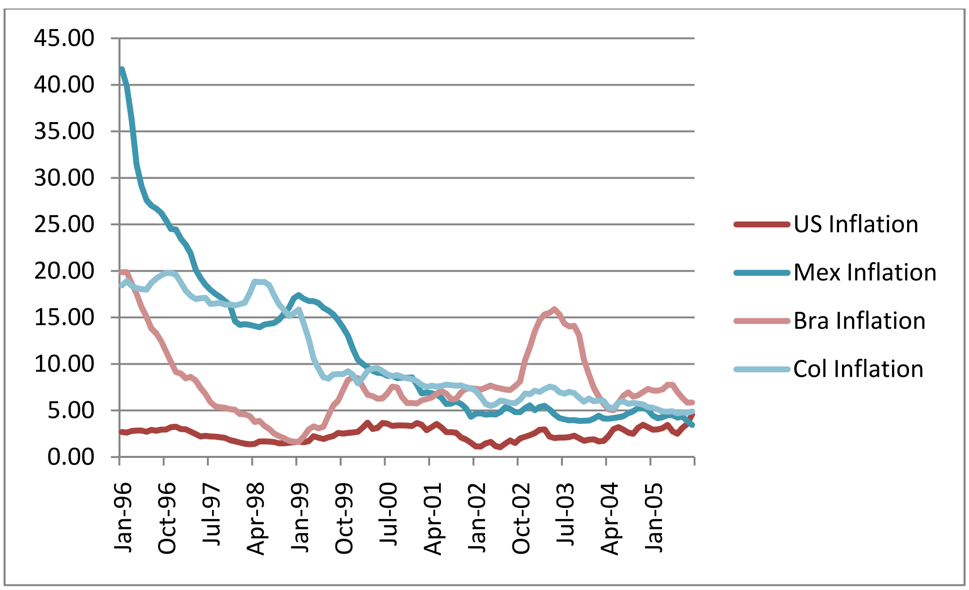

Chart 3: Linear output gap Jan-96 to Sept-05

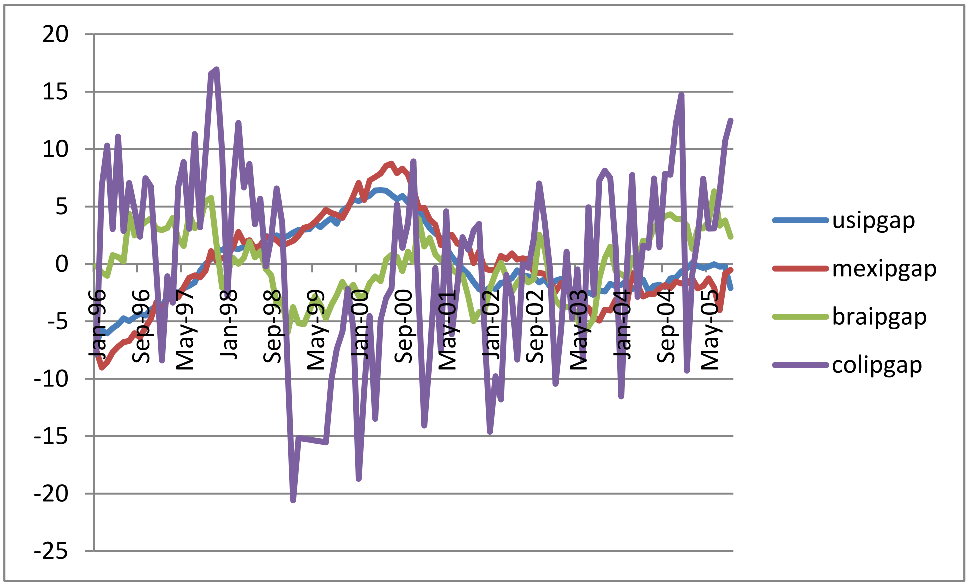

Chart 4: Quadratic output gap Jan-96 to Sept-05

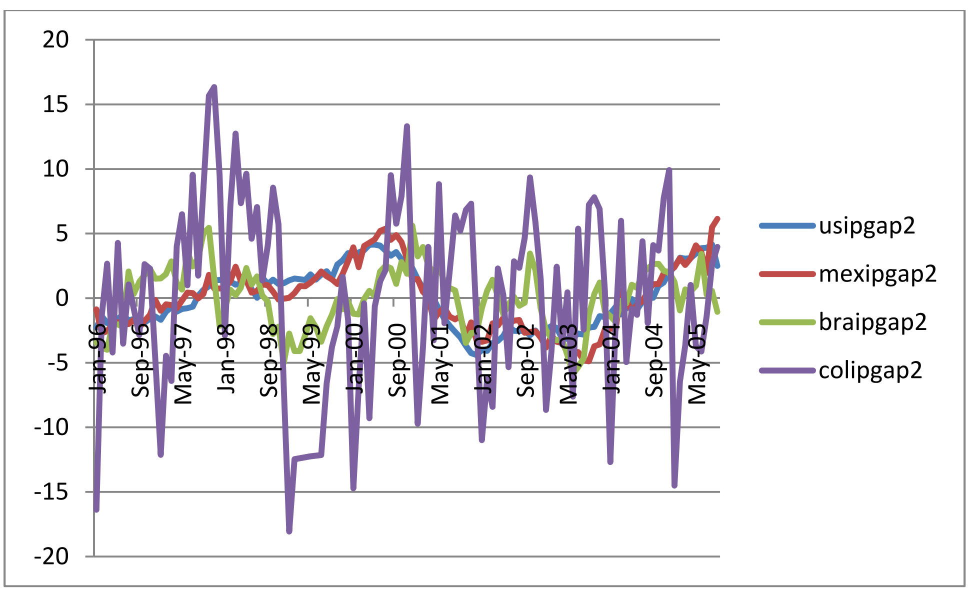

Table 7.1: US Taylor L(4)

US Taylor L(4)	Coefficient	T-statistic	P-value
US Inflation	0.219	3.06	0.003
US output gap	0.063	3.14	0.002
Federal Funds Rate (T-4)	0.879	28.14	0.000
R^2 = 0.922			

Table 7.2: Mexican Taylor L(1)

Mexico's Intrest rate model (Galindo)	Coefficient	T-statistic	P-value
Mexico's Inflation	0.183	2.38	0.019
Mexico's output gap	0.138	2.06	0.041
Mexico Money Market Rate (T-1)	0.809	13.38	0.000
R^2 = 0.94			

Chart 5: Mexico's money market plotted against regression from table 4.9 Jan-96 to Sept-05

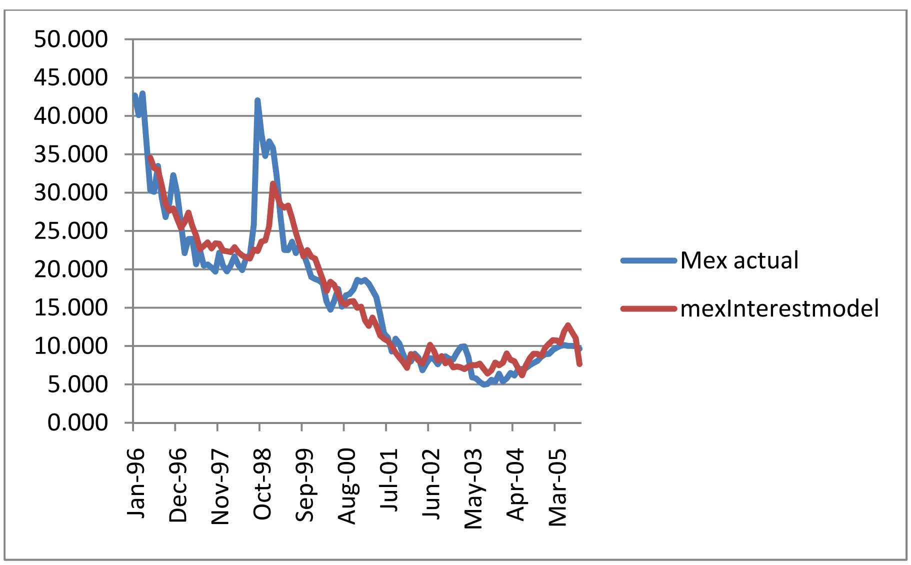

Chart 6: Brazil's money market plotted against regression from table 4.9 Jan-96 to Sept-05

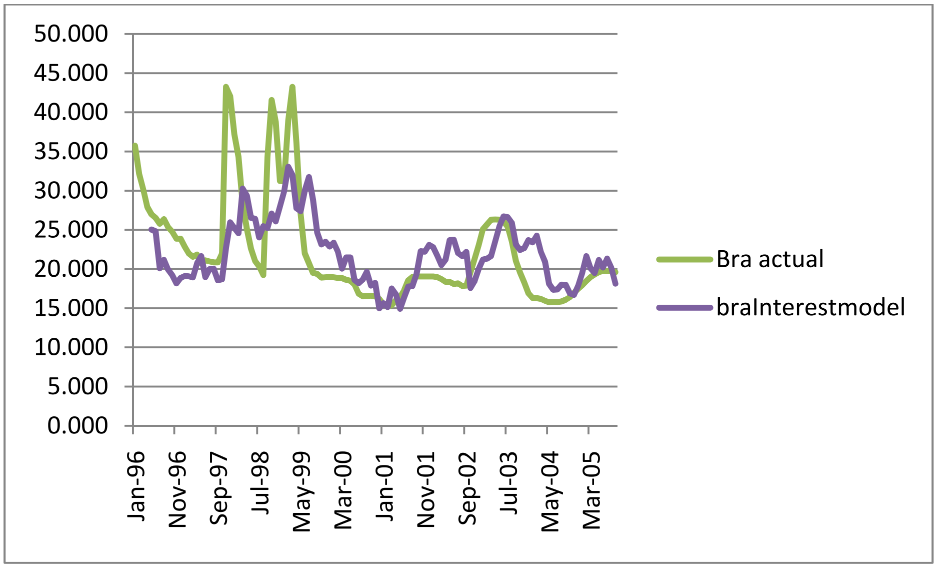

Chart 7: Colombia's money market plotted against regression from table 4.9 Jan-96 to Sept-05

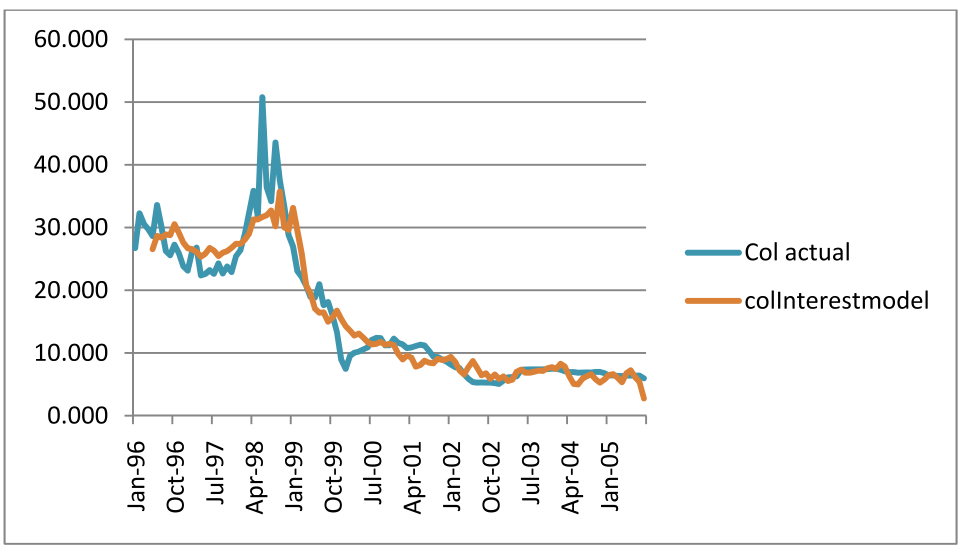

Chart 8: Mexico’s residuals Autocorrelation Function

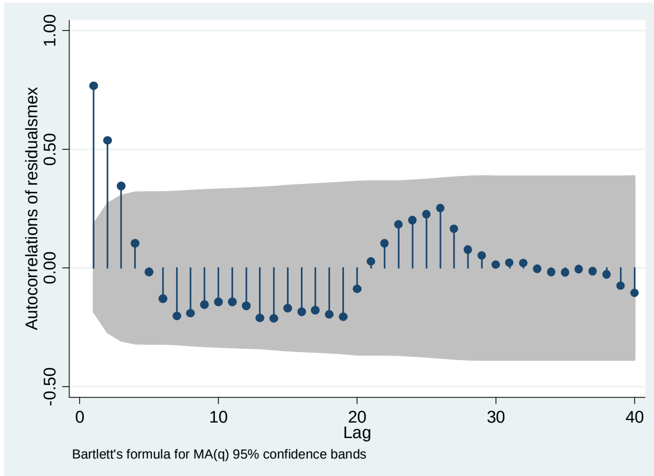

Chart 9: Mexico’s residuals Partial Autocorrelation Function

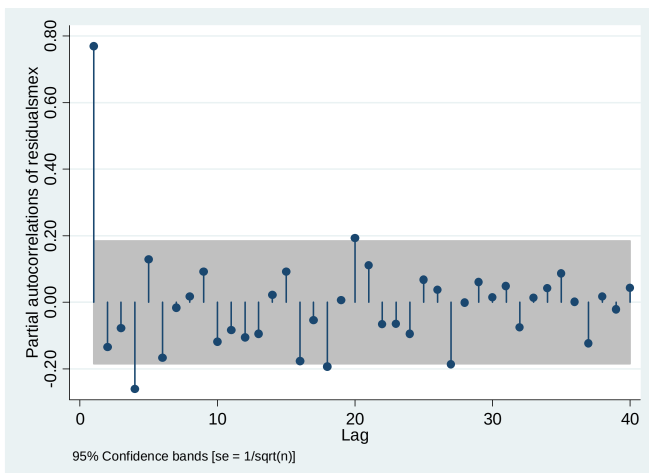

Chart 10: Brazil’s residuals Autocorrelation Function

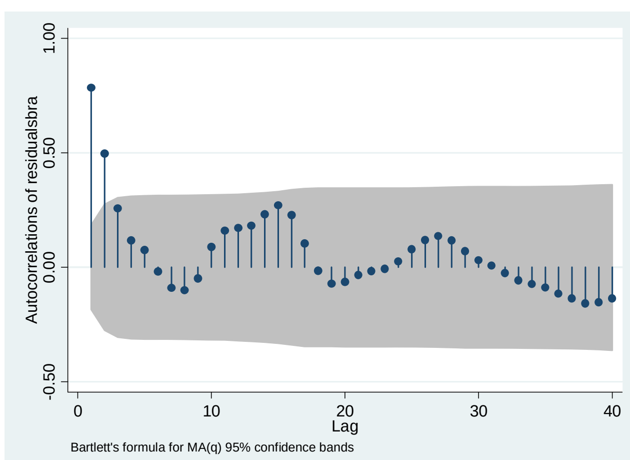

Chart 11: Brazil's residuals Partial Autocorrelation Function

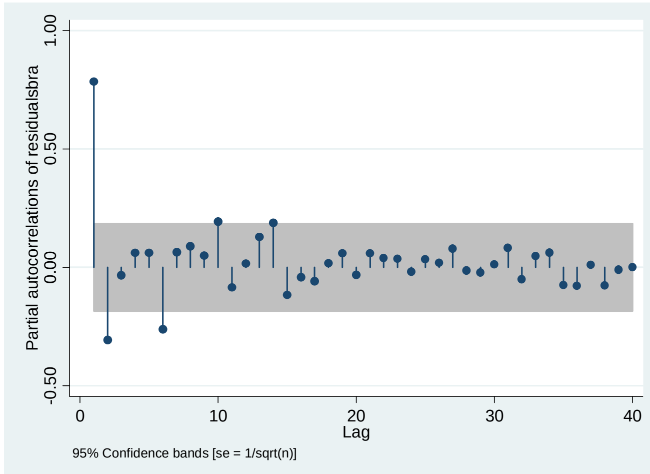

Chart 12: Colombia's residuals Autocorrelation Function

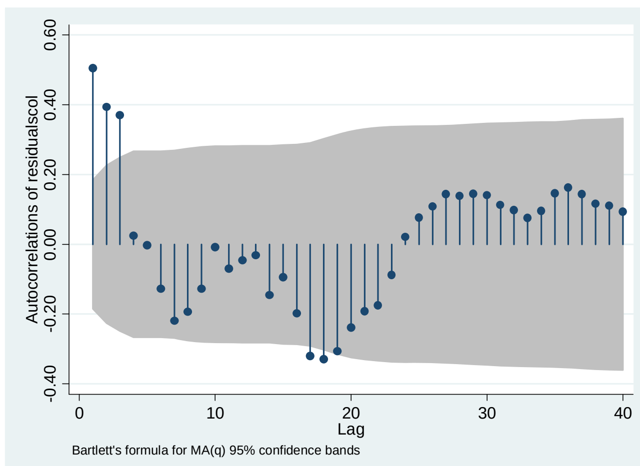

Chart 13: Colombia's residuals Partial Autocorrelation Function